*A United Family Prospers**: Do Spouse-regarding Preferences Shape Household Production and Income?

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Abstract

Household production builds on the basis of cooperation among family members. However, field evidence on the extent to which variation in intrahousehold relationships accounts for household economic outcomes like income is altogether missing. Here, combining experimental measures of spouse-regarding preferences and household survey data for a sample of rural households in Burkina Faso, I find a great variation in spouses' experimental behaviors, which explains substantial differences in real-world household income: (i) controlling for household-level covariates, households in which at least one member is approximately indifferent between payments to her spouse and to herself, have substantially higher income than those whose members either prefer payments to themselves or strictly prefer payments to their spouses; (ii) women's experimental types provide majority of the explanatory power. Providing suggestive evidence of causality, I argue that the causal relationship is inconsistent with a unitary model, a collective model, or some existing noncooperative models. Instead I develop a noncooperative household production model with commitment failure to reconcile the empirical findings, which predicts intrahousehold productive inefficiency when individual spouses lack willingness to act collectively.

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*A Chinese Proverb.

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1 Introduction

Economic productions are carried out in teams taking the forms of firms, communities and households. Cooperation and coordination among its members apparently matter for an organization's economic performance. However, there lacks empirical evidence on the extent to which relationships among members within these organizations account for their economic outcomes. Social preference experiments, which are majorly played among strangers and used to study individuals' prosocial preferences in general, have recently been proven also a powerful tool to elicit features of established relationships. The elicited prosocial preferences among community members, for example, demonstrate great predictive power for real-world collective behavior and outcomes, such as soil and water conservation (Bouma et al., 2008) and forest management outcomes (Rustagi et al., 2010).

In this paper I look at producer-consumer households, which are probably the smallest social entity of economic production, but produce nearly 70% of all food consumed worldwide (FAO, 2013) (in the case of small-holder farmers), and carry the hope that they can fuel broader economic growth in developing countries (in the case of micro-enterprises) (Fiala, 2015). With a sample of rural Burkina households, I examine how the intrahousehold relationships shape household production and therefore play a role in determining total household income. I define spouse-regarding preference as the extent to which individuals concern about their spouses' payoffs relative to their own payoffs. I experimentally measure such preferences, and find that variations in the experimental measure account for substantial differences in household income.

With the help of a theoretical model, I depict the mechanism how exactly the spouse-regarding preferences can transform as individuals' subjective willingness to act collectively, which in turn determines intrahousehold productive efficiency and therefore household income. I argue that the empirical findings are only compatible with this noncooperative household production model in which intrahousehold productive inefficiency arises due to commitment failure. Hence the empirical evidence contributes to the long-debated question

of how to economically model household behavior (see Chiappori and Mazzocco 2014 for a review). It also cautions poverty-alleviating interventions like technology transfer programs, to pay more attention to relationships within households, understand the intrahousehold dynamics, what is driving them, and how that will affect the outcomes the intervention is intended to change.

To assess the role of spouse-regarding preferences in household production and income, I use a unique combination of two data sources. First, I use household survey data on household expenditure as a proxy for household income, and also variables of households' productive asset holding and other socioeconomic characteristics as controls. Second, I conduct a series of mini-dictator games between spouses to provide a measure of spouse-regarding preferences, which are essentially individuals' subjective valuations of payments given to their spouses relative to payments given to themselves. In the experiment, respondents make a series of either-or choices between an amount of payment given to themselves and another amount of payment given to their spouses.[1] Respondents are told that one of all the choices is randomly chosen to decide the real final payment. The switch point where a respondent changes from choosing one payment to the other reveals his relative valuation of these two types of payments.

I find a great variation in spouses' experimental choices. More important, utilizing such a variation, I find clear evidence that spouse-regarding preferences play a role in determining total household income after controlling for productive assets, socio-economic characteristics and village-fixed effect. Households where at least one spouse (approximately) equivalently values payment given to the spouse and that to oneself (which account for about 33% of the sample) have significantly higher conditional income than the rest of the households (67% of the sample). The income gap between the different experimental types ranges from 17 to 27 percent depending on different specifications.

[1]In standard dictator games, respondents have multiple (or even infinite) choice options about how to divide a total endowment, while here in these *mini-dictator games* they only have two choice options in each choice (with different amounts of total endowments).

Interestingly the income gap is not solely driven by spouses preferring own payment. Those households where individuals strictly prefer payments given to spouses is also associated with an income gap with a slightly smaller magnitude. In other words, being *overly altruistic* seems to be counter-productive. Moreover, I find that women's experimental behavior exhibits much greater predictive power than men's, implying women's pivotal role in household production. I also find that such income gap associated with the household's experimental type is much greater if the household head is not a farmer. Showing that such a pattern is not due to different explanatory powers of the control variables in the basic regression for the two subsamples, I argue that this suggests a greater influence of spousal cooperation for the small business households than the farmer households. In addition, I provide suggestive evidence of causality: by showing no strong correlation between the household experimental type and productive assets, I argue that reverse causality is not driving the data generation process; the main results are also robust after including several potentially correlated variables to the regression.

To understand the mechanism how spouse-regarding preferences can causally influence total household income, I develop a noncooperative household production model with commitment failure, under the assumption of imperfect input markets. In the model, each spouse owns a personal plot of land (the fixed input) , has (at least nominal) control over the profit generated from that plot, and voluntarily allocates the labor (the variable input) at his/her disposal across the two plots. Intrahousehold productive efficiency requires the relatively labor-abundant spouse to offer net labor input transfer onto the other spouse's plot. This happens if this labor-abundant spouse equivalently views her own profit and her spouse's profit, thereby has the willingness to act fully cooperatively and maximize the total household income. However, if she marginally prefers her own profit, then she will underinvest in her spouse's plot, assuming no credible commitment of compensation can be made between the spouses. Thus the household as a whole will suffer income loss, even though the labor-abundant spouse enjoys greater personal utility given the existing intrahousehold allo-

cation scheme. As to the other side of the story, i.e., when the pivotal spouse strictly prefers payments for their spouses (MRS bigger than one), the model also predicts that productive inefficiency arises, as the pivotal spouse over-invests her labor on the other spouse's plot.

Such a prediction is consistent with the empirical result. If we interpret the experimental elicitations of spouse-regarding preference as the individual's marginal rate of substitution (MRS) between profits for one's spouse and for oneself, then the empirical finding can be put as that households where at least one spouse's MRS (approximately) equals one has substantially greater income than those whose spouses have MRS's smaller or strictly greater than one. With the help of the theoretical analysis, I further discuss what could possibly lead to the empirical findings concerning women's pivotal roles, as well as the heterogenous effect between farmer and non-farmer households. I also provide tentative interpretation of the overly altruistic behaviors in the experiment (MRS's strictly greater than one) beyond the noncooperative production model. I argue that the results imply that social norms such as the obedient gender norm of women's may have played a counter-productive role in household production. Nevertheless, taking the income gap as efficiency loss from household production for the whole sample, I calculate an average of about 12-19 percent income loss.

Empowered by such theoretical analysis, this paper demonstrates how spouse-regarding preference elicitation with a focus on the the features of the ongoing intrahousehold allocation scheme provides a lens looking into intrahousehold decision-making and thereby contributing to the long-debated question of how to economically model household behavior. Theoretical models viewing the household as an individual decision maker (for example Becker's (1974) unitary model) and those assuming agents are able to make binding commitments and obtain Pareto optimal outcomes (for example Chiappori's (1997) collective model), inherently dismiss the relevance of spouse-regarding preferences in household production. They all unequivocally predict that spouses would be indifferent between payments given to each other, since the benevolent dictatorship or the intrahousehold bargaining process is supposed to reconcile the different preferences of members, and perfectly align their incentives. However,

intrahousehold productive Pareto efficiency is contradicted not only by the lab-in-the field experimental results that I will introduce momentarily, but also by empirical evidence using plot-level production data (Udry et al., 1995; Udry, 1996; Goldstein and Udry, 2008; Akresh, 2008), as well as those rejecting complete insurance within the household using observational data or randomized control trials (Duflo and Udry, 2004; Robinson, 2012; Schaner, ming).

Theoretical modelers speculate about how such inefficiency arises. It is still unclear whether spouses fail to act in a collectively rational manner because they constantly face a positive probability of divorce (Telalagic, 2014), they are acting strategically to build up future bargaining power (Lundberg and Pollak, 1994 and Basu, 2006), or they simply fail to make credible commitments even within the marriage concerning a relatively short period of time. The current study fits into the large volume of empirical literature supporting the existence of intrahousehold productive inefficiency. More important, it distinguishes itself by explicitly suggesting the commitment failure model as the most plausible explanation.

Last, this paper most closely belongs to an emerging literature that use an array of social preference experiments to directly test intrahousehold allocative efficiency. Iversen et al. (2011) and Kebede et al. (2013) played variants of public good games among married couples in rural Uganda and Ethiopia, respectively; Cochard et al. (2009) played prisoners' dilemma with couples in France; Mani (2011), Hoel (2015), Fiala (2015) and Beblo et al. (2013) played adjusted dictator games with couples respectively in rural India, rural Kenya, rural Uganda, and Germany and France; and Castilla (2015) played a trust game between spouses in India. In all these experiments, researchers find substantial deviations from Pareto optimality at the household level, even though spouses do tend to be more cooperative than strangers. Some of this work investigates the determinants of the spouse-regarding preferences elicited: for instance, contributions to the common pool in the public good game tend to be higher when spouses have similar occupations and education levels (Iversen et al., 2011); and those individuals with higher intrahousehold bargaining power tend to pass more to the spouse as a sender (Castilla, 2015).

None of these studies put into empirical test the predictive power of spouse-regarding preferences for real-world behavior or outcomes; except Fiala (2015) who shows that husbands' and wives' experimental behavior can help explain the heterogeneous treatment effect of a loan-with-training program in increasing microenterprises' profits in Uganda. The current paper contributes to this literature by proposing a simple but powerful experimental design, and also as the first to examine the role of spousal relationships in explaining differences in total household income. My findings also provide external validity to lab-in-the-field experiments between spouses.

2 Background and Sample

2.1 Context

In this section I introduce the socioeconomic background of my study site, which is particularly favorable for the use of a noncooperative model of household behavior.The study site is located in west Burkina Faso (Danté District), a rain-fed rice and cotton cultivating area between the city of Bobo-Dioullaso and the Burkina-Mali border. In this section I introduce the local context based on both the descriptive literature on Burkina Faso and much of sub-Saharan Africa as well as individual interviews in focus groups I conducted prior to the experiment. A distinctive characteristic of the local farming system is that there are both "communal" plots and individual plots within households. Most households are headed by men who control the "communal" plots of the household and provide for the family's basic needs. Individual plots can belong to either men or women. Individual spouses have substantive control over cultivation decisions on their individual plots restricted by some social norms(Saito et al., 1994; Sanders et al., 1990; Jones, 1986). For example, one can decide to a great extent how much labor to allocate on her individual plot, although women commonly do have obligations to provide some labor for the communal (and sometimes men's personal) plots, domestic chores and childcare responsibilities (Abbas, 1997). Also, one can decide what to cultivate on the individual plot, while some crops are gender-specific, -men

mainly cultivate staples and cash crops, while fruits and vegetables are more considered as female crops.

Individuals claim a great extent of control over output from their individual plots, and have some autonomy to decide how to use the generated income (Jones, 1983; Saito et al., 1994). Women often bring extra nutritional and flavorful food like vegetables and spices to the family table from their individual earnings and sometimes use income from her individual plots to support her kin from the birth family (Roth and Badini-Kinda, 2007). As Udry (1996, p1017) summarizes, "the rhetoric surrounding these individual plots is that the output can be used (with some restrictions, which vary across localities) in accordance with the individual's desires." Therefore both men and women care more about output on their own plots (Davison 1988 and Dey 1993).

Men and women get land ownership in different ways. Men gain access to land from their birth families or arrangements set by village chiefs, while women mostly acquire her plots from their husband when marrying into the family. Thus the initial land allocation at the beginning of the marriage reflects characteristics of the marriage market (Udry, 1996). Meanwhile the individual control over the plots often persists over time after the marriage. In terms of marriage customs, divorce is rare in this area and divorcees bear a social stigma. Polygamy is widely practiced. Traditionally the older wives have greater status in the family, but as the younger wives are often healthier, stronger, and more favored by the husband, in many families, they can also have greater bargaining power than the older wives.

2.2 Sample and Household Survey Data

The sample is a subset of participating households in a large-scale nutrition supplementation project, the Burkina trial of the International Lipid-Based Nutrient Supplements (iLiNS-Zinc) Project.[2] The project freely provided small-quantity lipid-based nutrient supplements

[2]The iLiNS project also has trials in Malawi and Ghana; for details see http://www.ilins.org.

(SQ-LNS) plus monitoring and treatment of diarrhea and malaria to children 9 to 18 months of age on a rolling basis in order to identify the optimal level of zinc for inclusion in the SQ-LNS formula, and measure the efficacy of LNS in promoting child growth and development Hess and et al. (2015). Most of the household survey data used in the current article comes from a basic socioeconomic and demographic status survey and a household expenditures survey, administered at the project's baseline and midline, between June 2010 and June 2012.[3] We revisit a random subsample of the iLiNS households in 22 project villages from late December 2013 to January 2014. We end up having 151 monogamous households and 79 polygamous households with two wives in our final sample.

Table 1 presents the summary statistics of variables on the households' expenditure, productive assets and other socio-economic characteristic. I use the computed variable of total household consumption based on a standard consumption module as a proxy for total household income (See the Appendix for discussions on why using consumption as a proxy). The data shows great variations in total income across households, while on average the living standard for households in the sample is quite low: per capita income is about 1 dollar a day. The majority of the household heads (mostly men) are farmers, while the remaining 17 percent are mainly small business (local shop) owners (11 percent), with very occasional cases of herders, gardeners, craftsmen and waged workers. Besides the income variable, the household survey also provides information on productive assets as well as some basic socioeconomic characteristics. I discuss the construction and distribution of these asset variables in detail in the Appendix.

[3]A small part of the socioeconomic variables come from a short questionnaire conducted after our lab-in-the-field experiment.

3 Lab-in-the-field Experiment

3.1 Experimental Design

The purpose of the experiment is to elicit individuals' spouse-regarding preference, i.e., their subjective valuations of their spouses' payoffs relative to their own payoffs. In the experiment, the respondents played two rounds of *spouse game*s: the public payment and secret payment games. Each game is a multiple price list consisting of a series of mini-dictator games, i.e., dichotomous choices between different amounts of payment given to one's spouse and that given to oneself.[4] In all games, the respondent made all the decisions alone, and was told that his decisions would certainly remain hidden from his spouse. In the public payment game, the respondent was told that the payment to him, if chosen, would be given to him with the presence of his spouse; in the private payment game, the respondent was told that the payment to him, if chosen, would be given to him without the presence of his spouse and would remain private information.

All respondents played the private payment game first and then the public payment game. In a game, they made 14 dichotomous choices. As in Table 2, the amount of payment given to one's spouse decreases as the questions proceed, while the amount given to oneself stays fixed at 1000 CFA. 1000 CFA approximately equals 2 dollars, which is about two-day's income per capita for these households. In total, each respondent made 28 choices. The respondent was informed that one of all the choices would be randomly chosen to decide the final payment.

The switch point where a respondent changes from choosing payment given to herself to payment given to her spouse reveals a range for her relative valuation of these two types of payments. Such a revelation is incentive-compatible. The elicited measure is an economically intuitive concept, and can be readily interpreted under a theoretical framework of household

[4]The multiple price list design is also called the Becker–DeGroot–Marschak method, which is named after Gordon M. Becker, Morris H. DeGroot and Jacob Marschak for their 1964 Behavioral Science paper. It typically consists of a series of dichotomous choices between a monetary amount and a product, eliciting subjects' willingness to pay for the product.

production. Therefore I adopt such a multiple price list consisting of mini-dictator games instead of the commonly-used other-regarding preference games like standard dictator game, ultimatum game or trust game etc.

3.2 Implementation

We invited husband and wife to participate in the experiment together, but they were separated upon arrival to play spouse games independently and privately in separate sessions. They were not informed about their spouses' games; if asked, they were told that they did not need to consider their spouses' games and should concentrate on their own choices. These sessions were held in a private place either near the family's house, or in/around some village facilities like the village clinic, school or mosque, under the one-on-one instruction of an experiment administrator of the same gender. The language used in the experiment is either Dioula or Morri, which are the two most common local languages (See in the Appendix the experimental protocol in English and French).

When making the dichotomous choices, respondents were informed that if they were indifferent between the two options, then they did not have to choose one option but can instead report as "being indifferent". However, in our sample respondents seldom replied "being indifferent" for any choice question. To avoid being repetitive and also bring about unique switch points, once the respondent switched from choosing the payment given to herself to the 1000 CFA given to her spouse, instead of asking the remaining choice questions in the list, the experiment administrator would ask whether this meant that for any amount less than the current amount given to herself, she would also choose the 1000 CFA given to her spouse. In our sample all respondents respond positively to such questions if they switched. Some respondents chose 1000 CFA given to her spouse even in the first question, i.e., choosing 1000 CFA given to her spouse over 1100 CFA given to herself. Some respondents chose payment given to herself even if the amount is zero as in the fourteenth question, i.e., she would rather no one received any payment than having her spouse receive 1000 CFA.

For these two special cases, the experiment administrator would spend time to explain the rules of the game again, making sure that such choices are revealing true preferences but not due to poor understanding.

After finishing the 14 choices in each game, the administrator would toss a dice to determine one question as the candidate for deciding the final payment.[5] After finishing both the public payment and private payment games, the administrator would ask the respondent to draw a sealed envelope out of two. Each envelope contains a colored paper, while the blue paper represents the public payment game, and the green paper represents the private payment game. The dice and the envelope together randomly decides one choice out of the 28 choices in the spouse game for the final payment.

However, after conducting the focus group and pretests, and consulting the local human subject committee, we realized that the possibility of uneven payments among household members might cause problems in some households, even though this seemed not very likely. We eventually decided to act cautiously and give every respondent 1000 CFA, the maximum possible payment from the experiment. Nevertheless, we still followed the experimental procedures introduced above and informed the respondents that the final payment depends on their choices together with the random draws. Then after the experiment and final payments, we explained to the respondents why we end up giving them 1000 CFA instead, and asked their favor not to disclose the contents and payments of the experiments to other villagers, at least not before we finished our experiments in the village. With careful implementation, we believe that we were able to incentivize the experimental choices with beliefs of real payments, while avoiding any possible negative impacts on the respondents.

For the 79 polygamous households where there are two wives, the husband and both wives are all included in the experiment, and each individual plays the spouse game twice, each time

[5]The dice was ten-sided and had a number from 0-9 on each side, and the payment amount for oneself would be 100 times the number that the dice landed on. For example, if the dice landed on 2, choice question 10 where option A was 200 would be enforced. This means question 1, 2, 12 and 13 would never be chosen, but we believe the randomized payment successfully incentivizes the respondents to take the whole experiment seriously.

with one of the other two family members. A husband first plays a spouse game concerning payments to himself and to his first wife, and then another game concerning payments to himself and his second wife. A wife first plays a spouse game concerning payments to herself and her husband, and then another game concerning payments to herself and her cowife.

As many of the subjects are illiterate, a great amount of effort and time was put into making sure that they understood the experiment. Careful explanations took place step by step, from the basic concept of either-or choice questions to the incentivizing mechanism of randomly choosing one of the 14 questions to make real payment. Then we introduced the two different rounds concerning public earnings and private earnings. All subjects played a practice round before the real experiment. Coins of the exact real values are used by the administrators to vividly illustrate the questions.

3.3 Experimental Outcomes

The 539 individuals in the sample played a total of 618 spouse games between husband and wife.[6] I focus on the public payment game in the current work, so here I only report the outcomes of the public payment game; the outcomes of the private payment game, its comparison to the public payment game, and its (lack of) explanatory power for difference in household income, are the topic of another paper (Zou, 2015a).

There are three distinctive patterns of experimental choices along the list of dichotomous questions in the public payment game. First, in 3% of the games individuals (mostly from polygamous households) always choose payment for themselves, even if the amount is 0. This indicates that the subjective valuation of their spouses' payoffs relative to their own payoffs is less than or equal to zero. Second, 32% of all the respondents always choose the payment to their spouses, even if the payment to themselves is 1100 CFA. This indicates the subjective valuation is greater than or equal to 1.1. Third, 65% of the respondents choose payment to themselves first, and then switch to payment to their spouses as the amount for

[6]Husbands in polygamous households play two spouse games, one concerning his first wife, the other concerning his second wife. I do not include the games played between cowives here; it will be discussed in another paper.

themselves decreases. Then their switch point indicates a closed interval for their subjective valuations. For example, if a respondent chooses payment for herself when the amount is 600 CFA or more, and switches to payment for her spouse when the amount is 500 CFA or less, then the relative value for her of the two types of payment falls into the interval [0.5, 0.6]. Those who switch at 1000 CFA (22% of the whole sample) then has a subjective valuation that falls between [1, 1.1]; those who switch at 900 CFA (E% of the sample) has a subjective valuation between [0.9, 1].

I show the distribution of the experimental choices for women and men in Figure 1, and Figure 2, respectively. I define two subsamples that I will often refer to later in the paper: experimental choices between husband and wife in monogamous households are pooled together with that between husband and first wife in polygamous households to form the M-1F sample; experimental choices of monogamous households are pooled together with that between husband and the second wife in polygamous households to form the M-2F sample. The x axis on the graph indicates the lower bound of the interval for the relative value ; for the interval $(-\infty, 0]$ that does not have a lower bound, I denote it as -0.1 for convenience. As the graphs show, respondents tend to have subjective values either quite low, or relatively high; there are not many observations at specific moderate values.

I classify these spouse-regarding preferences into three groups to facilitate empirical analysis for later. Those who switch at 900 CFA or less are grouped as individuals who "prefer their own payoffs"; those who switch at 1000 CFA are grouped as individuals who are "approximately indifferent between their own payoffs and their spouses' payoffs"; those who always choose the 1000 CFA to their spouses are groups as individuals who "strictly prefer their spouses' payoffs". I report the pair-wise distribution matrix of couples' spouse-regarding preferences for the M-1F and M-2F sample in Table 3 and Table 4, respectively. As the tables show, very few couples (only 7 couples for either sample) both switch at 1000 CFA.

Note that "strictly preferring spouses' payoffs", i.e., choosing 1000 CFA given to their spouses over 1100 CFA given to themselves might seem a little peculiar. Given that they

are involved in the established relationship of marriage, the respondent can easily transfer all or part of his 1100 CFA to his spouse after the experiment, which seems preferable to 1000 CFA directly given to his spouse if we only consider material utilities. Besides the special experimental procedures that experiment administrators conduct in face of such peculiar choices, I also check with data to make sure that these choices are not due to poor understanding of the experiment. As shown in Figure 3, those who "strictly prefer their spouses' payoffs" have similar understanding levels as the rest of the sample according to the enumerators' ratings.

4 Empirical Analysis and Results

Before putting the theoretical predictions into empirical tests, I first establish a basic asset-income mapping model following the perspective of Sen's (1981) entitlement mapping and Carter and May's (1999) livelihood mapping. The regression follows the equation below:

$$ln(I_{iv}) = \alpha + \beta X_i + \eta_v + \epsilon_i \tag{1}$$

where I_{iv} is the total household consumption for household i in village v, as a proxy for the total household income; the natural log form is used to make sure the error term is normally distributed; η_v is the village-fixed effect. Following Sen, and Carter and May's broad definition, X_i include both tangible assets like land, labor, livestock and a housing and a durable index, and intangible assets like education, social capital etc. Including these primary determinants of household income as control variables allows the econometric regression to pick up the more subtle effects of spouse-regarding preference. The estimation results of the basic OLS regression is presented in columns (1) and (2) of Table 5, with R-squares of 0.429 and 0.447 for the whole sample and for the monogamous sample, respectively. See a detailed discussion on the rationale and results of the basic regressions in the Appendix. Overall, the basic model is able to capture a great portion of the inter-household variations in household

income.

4.1 Adding Experimental Elicitation to the Basic Regression

Adding the experimentally elicited spouse-regarding preferences to the basic specification in Eq.(**??**), the OLS regression model becomes:

$$ln(I_{iv}) = \alpha + \beta X_i + \gamma P_i + \eta_v + \epsilon_i \tag{2}$$

where P_i is the spouse-regarding preferences of members of household i. There are various ways to construct a variable or variables of spouse-regarding preferences. For example, the elicited relative value of each spouse can be directly included as a continuous variable; or the sample can be divided into different categories based on a single certain cut-off for the elicited relative value. However, including the experimental measure in the wrong way can disguise its explanatory power; the fact that the relative values are clustered at several points also limits the statistical power the data can provide. After theoretically-guided exploration, I find that constructing the experimental type variable distinguishing the three categories of "prefer their own payoffs", "approximately indifferent between their own payoffs and their spouses' payoffs", and "strictly prefer their spouses' payoffs", leads to intriguing empirical patterns that I introduce below.[7]

In columns (3)-(10) of Table 5, I present the OLS regression results adding the household-level experimental types. Controlling for all the available variables of productive assets, I find that households where at least one spouse is approximately indifferent between their own payoffs and their spouses' payoffs, have 17, 24 or 27 percent higher income than the remaining households using the M-1F, the M-2F or the monogamous sample, respectively. In column (5), instead of looking at M-1F and M-2F samples separately, I also generate a new dummy variable that equals one if at least one spouse is approximately indifferent

[7]In this paper I introduce the theoretical model after the empirical analysis to help interpret the results; in practice, the theoretical model was developed before and during the empirical analysis, and was able to provide guidance on how to conduct the empirical regressions.

for every couple within a family (there is indeed one couple in a monogamous household, and two couples in a polygamous household). The income gap associated with this dummy variable is as large as 26 percent. I further divide the experimental type where at least one spouse is approximately indifferent into: (a) households where both spouses are indifferent between payoffs given to each other, (b) households where there is only one spouse indifferent. However, only 7 households fall into subgroup (a), and the coefficients for this subgroup is unsurprisingly insignificant. Those households where only one spouse, especially the woman, is approximately indifferent, nevertheless have greater household income than the default group where spouses either prefer own payoffs or strictly prefer spouses' payoffs.

Comparing to the basic OLS as in columns (1) and (7), the experimental measures demonstrate considerably strong explanatory power. Joint F-tests of the experimental variables have p-values smaller than 1% in most cases. The adjusted R-square of the model increases from 0.429 to as high as 0.454 for the full sample, and increases from 0.447 to 0.486 for the monogamous subsample.

As a next step, I further distinguish the remaining households as (a) households where both spouses prefer their own payoffs, (b) households where both spouses strictly prefer their spouses' payoffs, and (c) households where one spouse prefer his own payoffs and the other prefers her spouse's payoffs. As shown in Table 6, the income differences between the experimental types found above, are not solely driven by a single subgroup. Even though the income gap is most significant both economically and statistically for the subgroup (a) here, the gaps for the subgroups also exist and are sometimes substantial. Looking at columns (4)-(6), we can see that the income gap for subgroup (c) is mainly driven by households where the wife strictly prefers the husband's payoffs and the husband prefers his own payoffs. Again, joint F-tests of the experimental variables have p-values around or smaller than 1% except for the M-1F sample. The adjusted R-square of the regression increases from 0.429 to as high as 0.453 for the full sample, and increases from 0.447 to 0.477 for the monogamy subsample.

Finally in Table 7, I include men and women's experimental types separately in the

regression. We can see that women's experimental types exhibit great explanatory power while men's experimental types are not statistically significant at all. The two subgroups of households where women prefer her own payoffs and households where women strictly prefer her husband's payoffs both contribute to the income difference. The p-values of the joint F-test when adding women's experimental types is below 10%. The adjusted R-square of the model increases from 0.429 up to as high as 0.450 for all households, and increases from 0.447 to 0.476 for the monogamous households. Results are similar if including both men and women's experimental types together, as shown in Table 8.

In sum, I find that the experimental measures of spouse-regarding preferences, especially that of women's, are highly correlated with total household income controlling for major productive assets and socio-economic characteristics of the household. A pattern exists in general that those households where at least one spouse (or the woman in particular) is indifferent between her own payoffs and her spouse's payoffs, have significantly higher income than the remaining households. Spouses (or the woman in particular) strictly preferring the other spouse's payoffs is associated with lower income, and the income gap is even larger for those who prefer their own payoffs.

4.2 Heterogeneous Effects

In this subsection, I examine whether the spouse-regarding preferences' effects on household income differ across households with different occupations, wealth levels and being polygamous or monogamous, using the experimental type dummy used in column (5) of Table 5 for all households. Table 9 shows that the income gap is about 20 percent for households where the husband's primary occupation is farmer, but is as large as 63 percent for the non-farmer households. Such a heterogeneous effect can not be explained away by the difference in wealth or the propensity to be polygamy between farmer and non-farmer households, as shown in columns (2)-(4). Nevertheless, the income gap is not statistically different across households with different levels of the housing index, or across polygamous and monogamous households, but slightly larger for those with higher levels of the asset

index. I also include the interaction terms with the farmer dummy for the regressions using the individual spouses' experimental types as in Table 7, and the results are more mixed (See Table refOLSinteractionwho).

Nevertheless, the larger effect for the non-farmer households could simply be due to that the basic OLS model without the experimental types performs worse explaining the non-farmer's income variations than that of the farmer households. To check whether this is the case, I plot the residuals from the basic model as in Equation (2) against the housing quality index in Figure (4), separating farmer households and non-farmer households. As the figure shows, the 95% confidence intervals are almost identical; the means of the residuals by the two groups are not statistically different from each other. Therefore, the heterogeneous effects among farmer and non-farmer households do not seem to be caused by a different explanatory power of the basic OLS's.

4.3 Suggestive Evidence of Causality

The correlation between the experimental measure of spouse-regarding preferences and household income can be causal, i.e., spousal cooperation plays a role in determining household production and therefore total household income. However, alternative data generation processes can also give rise to what we empirically observe here. One possible mechanism is reverse causality: spouses in poorer households act less collectively, as poverty brings psychological stress that erodes spousal relationships. As in Eq.(3), I regress the experimental type on the productive asset variables from the major regression. If inverse causality were the major driving force, then we should find that those with greater productive assets act more collectively in the experiment.

$$P_i = a + bX_i + \sigma_i \tag{3}$$

As shown in Table 11, these variables that explain a great part of variations in total household income are only able to explain a very small part of variations in the experimental

measures. In columns (1)-(3), I report the most relevant regressions, where the independent variables are the experimental type dummies included in columns (2), (4) and (6) of Table 7, respectively. Note that total land area for farmer households has a positive impact on the experimental dummy that is significant at the 10% level. In addition, being polygamy, and having the woman join production-related associations both have negative impacts on the experimental type that is significant at the 5% and 1% level, respectively. However, the regression performs poorly overall; the adjusted R-square of the model is only 0.044, -0.011, and 0.102, respectively. In columns (4)-(7), I use individuals' experimental types as the independent variable instead. The regressions in general provide similarly poor explanatory power accounting for differences in households' experimental behaviors.

Endogeneity can also arise because of omitted variables that are correlated with both household income and spouse-regarding preferences. To shed some light on how severe such a problem could be, I conduct more regressions to check whether the main results are robust, excluding or adding covariates to the regression. One possible story is that individuals with greater innate abilities are more likely to develop cooperative spousal relationships, as they are better at finding a way to reconcile the preference differences. Failing to control for innate abilities can bias the income gap estimate upward. Therefore I include additional socioeconomic variables of the household head, -age, ethnicity and religion in the regression (see columns (3) and (4) in Table 12), which to some extent can serve as proxies of unobserved variables like ability. Another example would be when the husband has a habit like drinking, smoking or gambling that can hamper his productivity and/or decrease household income, which at the same time can deteriorate the relationship between him and his wife. In columns (5) and (6) I additionally include dummies indicating whether the husband drinks, smokes and gambles according to the wife's answer in the household survey. Spouse-regarding preferences are also correlated with individuals' intrahousehold bargaining power, which can directly influence total household income besides through the channel of intrahousehold cooperation. Therefore in column (7) and (8), I additionally include individual spouses'

personal plots as a share of the household's total land areas, to some extent controlling for the intrahousehold power balance.

Furthermore, since the spouse-regarding preference measures are experimentally elicited, the hawthorne effect can introduce endogeneity: respondents with higher education and cognitive understanding abilities that positively contribute to household income, are also more likely to better understand (or guess) the intention of the researchers and therefore choose the answers that seem to be more socially desirable (i.e., more likely to choose payment to their spouses in our case). In column (9) and (10) I additionally include the enumerators' ratings of individuals' understanding level of the experiment. In column (1) and (2), I also exclude the wealth indices and the Polygamy dummy from the initial specification as another robustness check.

As Table 12 shows, across all the columns the experimental types consistently exhibit considerable explanatory power, and in general the coefficient estimates are similar to that in Table 5. Overall, analyses in this subsection can not completely rule out alternative explanations of the main empirical results, but provide suggestive evidence in support of the causality interpretation.

4.4 Robustness Checks

To further check whether the results are robust, first I repeat the regressions restricting to certain subsamples. In the Appendix, I report the results, repeating the regressions in Table 12 for the monogamy sample, the farmer households sample, and monogamous farmer households sample, respectively. The income gap associated with households where both spouses prefer their own payoffs is the most robust across all the regressions, while that associated with the other experimental types often becomes statistically insignificant.

Then, I also separate households where the woman switches to choosing for her husband when payment for herself is 900 CFA as a single group, as arguably they are "approximately indifferent" between the two types of payments as well. As Table 13 shows, the same results hold for households where women strictly prefers spouses' payoffs as well as for those where

the elicited relative value is lower than 0.9. The conditional household income between those where women switch at 900 CFA and the default group, those where women switch at 1000 CFA, is not statistically different from each other. However, note that there is still a substantial negative income gap when including the polygamous households, even though not statistically significant.

5 Model

Understanding the empirical correlation clearly calls for a model in which individuals face trade-offs between their spouses' and own payoffs in the household production system. In this section, I develop a one-product, single technology noncooperative production model embedding such trade-offs, then I go back to the empirical findings to interpret them in light of the theoretical predictions. I also discuss other types of household production models, which all fail to reconcile the empirical patterns in our data.

5.1 Model Set-up

I model the production and consumption of a representative consumer-producer household as a two-stage sequential game.[8] In the first stage of production, individual spouses hold exogenously determined endowments in land ($\bar{K_i}$) and labor ($\bar{L^i}$), and autonomously allocate their labor across each other's plots, taking the other spouse's labor allocation as given. On both plots spouses produce a single crop, using a common technology, and generate profits that go under the plot owner's control. Standard assumptions are made concerning the production function $Q(K, L)$: diminishing marginal returns in labor (L), positive cross partial

[8]By modeling production and consumption as two consecutive stages, I am implicitly assuming that spouses' labor can only be allocated to household production, but not to the production of household public goods. This might seem unrealistic at first glance, but it is reasonable given the context. Local social norms strongly associate gender roles to domestic duties, -women are supposed to do housework and take care of young children; men who help their wives with these responsibilities would be laughed at or despised upon by people in their social network. In a sense, labor allocation to household public good production does not seem to be an active choice variable here, but more of an exogenous deduction from women's original labor endowment.

effects between L and land (K), and constant returns to scale (CRS). In the second stage, spouses spend the generated income on different aspects of household consumption. The sub-game perfect equilibrium can be derived by backward induction, i.e., first finding the equilibrium consumption allocation taking the income as given, then solving the intrahousehold labor allocation in the production stage foreseeing the consumption arrangements.

Another key assumption is market imperfection. In this simple version of the model, I assume that land and labor markets are missing while the product market is perfect. The predictions should still hold if I extend it to imperfect factor and product markets.

5.2 The Consumption Stage

Leaving the explicit modeling of the consumption stage to a separate paper (Zou, 2015b), here I only provide an descriptive account of the consumption stage. After the production stage determines individual earnings, spouses may make intrahousehold consumption decisions in various ways. Various features of the consumption stage influence the formation of spouse-regarding preferences, such as to what extent individual property rights are enforced within households, under what rules common or individual income is shared within the household, the existence and scale of household public goods, the similarity of spouses' material preferences, individual decision-making power. There can also be psychological factors like altruism, fairness concerns, and reciprocity, as well as influences of social norms.

Formally, I assume that individuals' indirect utility functions are $u_i(I_i, I_{-i})$, and I define each spouses' spousal-regarding preference as the individual's marginal rate of substitution (MRS) of his spouse's income for his own income: $MRS_i = \frac{\frac{\partial u_i}{\partial I_{-i}}}{\frac{\partial u_i}{\partial I_i}}$, i.e., MRS_i measures the marginal utility of one's spouse's individual earnings over that of one's own individual earnings[9]. As in Figure 5, the utility functions can be represented by the indifference curves (IC's) in terms of I_m and I_f . The slope of the man's IC's and the woman's IC's at a certain point equal MRS_m and $\frac{1}{MRS_f}$, respectively, with I_m and I_f's values at that point.

[9]The indirect utility function $u_i(I_i, I_{-i})$ can be interpreted as derived from any type of consumption model. See Zou (2015b) for the derivation of the indirect utility functions.

An extreme case is that spouses pool all their individual earnings together. With the pooled household income, either a benevolent household head alone makes consumption decisions according to his preferences (as in a unitary model of (Becker, 1974)); or individuals split it according to an exogenous sharing rule, regardless of the sources of the income (for example, as modeled in Telalagic, 2014). Alternatively spouses bargain and make collective decisions, where each spouse's bargaining power decides the extent that his personal preference is reflected in the household's final decisions on expenditures (as in a collective model of Browning et al. (1994); Browning and Chiappori (1998)). In all these cases, spouses would value marginal increases in each other's earnings (that are too small to change each spouse's bargaining power) equivalently: $MRS_i = 1$, the IC's are 45 degree straight lines.

An opposite extreme case is that individual spouses exert full control over all their own individual earnings, form separate income accounts, and make consumption decisions noncooperatively. Each spouse autonomously decides how to split income in his own accounts between household public goods and individual private goods, taking the consumption decisions of the other spouse as given. Under certain circumstances, such individual property rights enforced within the family together with noncooperative bargaining can induce a disparity in the marginal utility one's own earnings and one's spouse's earnings provide. Intuitively, individuals realize that an extra dollar given to their spouses will benefit them less, compared to that given to themselves, as it will be spent on different things. This makes them willing to sacrifice some household income for greater individual control over the earnings, if given the choice: $MRS_i < 1$.

Beyond the scope of standard models, individuals might also strictly prefer their spouses' earnings over their own earnings, i.e., $MRS_f > 1$. For example, revealing such a preference itself could have warm-glow effect on the individual (Andreoni, 1989). If such impure altruism brings utilities exceeding the difference in material utilities, then individuals would be willing to "pay" for feeling good about themselves. Another subtly different example could be that a social norm exists advocating no matter what women always putting their husbands' earnings

as priority. If the disutility of violating the norm is large enough, women would be willing to let go own earnings for a smaller amount of their husbands' earnings.

5.3 The Production Stage and Predictions

While being agnostic about the type of bargaining model that prevails in the consumption stage, I fix the production stage as a noncooperative model. Before formally solving the noncooperative model, below I first derive conditions the intrahousehold labor allocation must satisfy in order to maximize total household income.

5.3.1 The Efficient Labor Allocation

Intrahousehold productive efficiency is attained when household labor is allocated across plots so that total household income is maximized given the household's total factor endowments and available technologies. Formally, the efficient labor allocation across the two plots maximizes total household income:

$$\begin{aligned} & \underset{L_f,\, L_m}{max}\ I_h = I_m + I_h \\ s.t.\quad & I_f = pQ(\bar{K_f},\ L_f) \\ & I_m = pQ(\bar{K_f},\ L_m) \\ & L_f \geq 0;\ L_m \geq 0;\ L_f + L_m \leq \bar{L} \end{aligned}$$

The F.O.C. condition as in Eq.(4) is simply that the marginal value product of household labor working on the man's plot should equal that on the woman's plot:

$$\frac{\partial Q(\bar{K_f},\ L_f^*)}{\partial L} - \frac{\partial Q(\bar{K_m},\ L_m^*)}{\partial L} = 0. \tag{4}$$

Figure 6 plots the household's production possibility frontier (PPF) in terms of I_m and I_f, illustrating an example when the man has a larger plot than the woman.[10] The slope at

[10]Assuming $Q(.)$ is invertible, strictly increasing, second differentiable and strictly concave in L, *the PPF*

any point represents the marginal rate of transformation (MRT) between I_f and I_m given their values at that point. The household income is maximized at point H as I_{max}, where the 45 degree line tangentially hits the PPF.

The position of the individual autarky point relative to point H indicates the relative scarcity of labor within the household. Taking the example on the graph, the autarky point where spouses exclusively work on their own plots, point E, is to the right of point H, so the woman is relatively labor-abundant, as she has more labor than total household income maximization requires. Formally, define the optimal labor-land ratio for spouse i's plot as $\tau_i^* = \frac{L_i^*}{\bar{K}_i}$, and the labor-land ratio of spouses i's initial endowment as $\tau_i^o = \frac{\bar{L}^i}{\bar{K}_i}$. If $\tau_i^o > \tau_i^*$, then spouse i is relatively *labor-abundant*, and the other spouse is relatively *labor-scarce.*

5.3.2 The Individually Optimal Labor Allocation

As a noncooperative game, each individual allocates his labor across the two plots, taking the other spouse's labor allocation as given. One can neither force the spouse to work on one's plot nor prevent her from working on one's plot. For $i = f,\ m$:

$$\begin{aligned} & \max_{L_i^i,\, L_j^i} u_i(I_i,\ I_j) \\ s.t. \qquad & I_i = p_i Q_i(\bar{K}_i,\ L_i^i + \tilde{L_i^j}) \\ & I_j = p_j Q_j(\bar{K}_j,\ \tilde{L_j^j} + L_j^i) \\ & L_j^i + L_i^i \leq \bar{L}^i \end{aligned}$$

where $\tilde{L_i^j}$ and $\tilde{L_j^j}$ are spouse i's beliefs about spouse j's labor allocations, and there are also the usual non-negativity constraints:$L_j^i \geq 0,\ L_i^i \geq 0$. While leaving the formal analytical solution to the Appendix, here I apply a graphical approach to derive the Nash equilibrium of the model and demonstrate the underlying intuition. Formally, the Kuhn-Tucker conditions for spouse i's optimization problem are:

curve on the diagram is concave from the origin (See proof in Appendix **??**).

$$\frac{\partial u_i(I_i,\ I_j)}{\partial I_i} * p_i \frac{\partial Q_i(\bar{K}_i,\ L_i^i + \bar{L_i^j}))}{\partial L} - \frac{\partial u_i(I_i,\ I_j)}{\partial I_j} * p_j \frac{\partial Q_j(\bar{K}_j,\ L_j^i + \bar{L_j^j}))}{\partial L} + \lambda_i - \eta_i \qquad (5)$$

$$\lambda_i L_i^i = 0 \qquad (6)$$

$$\eta_i(\bar{L^i} - L_i^i) = 0 \qquad (7)$$

Solving both players' Kuhn-Tucker conditions simultaneously, we can derive the Nash equilibrium. While leaving the rigorous analysis of the different cases of solutions to the Appendix, here it is easy to see that when there is an interior solution ($\lambda_i = 0$, $\eta_i = 0$), Eq. (5) is equivalent to Eq. (4) if and only if $\frac{\partial u_i(I_i,\ I_j)}{\partial I_i} = \frac{\partial u_i(I_i,\ I_j)}{\partial I_j}$. In other words, given interior solution, $MRS_i = 1$ is the sufficient and necessary condition for intrahousehold productive efficiency.

Graphical illustration

To better understand the intuition and also discuss the relative importance of the two spouses' roles in household production, I introduce the graphical analysis here. Figure 3 shows an example when the man has a larger plot, the woman is relatively labor-abundant, and spouses have MRS's smaller than or equal to one. Holding IC_m constant where it hits the PPF tangentially at point M, I discuss three cases of IC_f. First, assume IC_f hits the PPF tangentially at point H. Points M and H are respectively the man's and the woman's most preferred points, and we do not know which point will be the equilibrium outcome without further analysis. Suppose we start from point E, where each spouse only works on his own plot. Taking the woman's decision as given, the man could possibly reallocate her labor away from his own plot towards the woman's plot, therefore reduce I_m and increase I_f, moving along the PPF downward. However moving along the PPF downward from point E makes him worse off, so he has no incentive to do so. In contrast, starting from E, the woman can and will reallocate some her labor onto the man's plot and thus move along the PPF upward, and she will stop at her most preferred point, H. The Nash equilibrium at

point H is where neither of the spouses has an incentive to reallocate their labor. Note that because the woman is the labor-abundant spouse and $MRS_f = 1$ at the equilibrium (i.e. her indifference curve is the 45-degree line), the Nash equilibrium coincides with the Pareto optimal intrahousehold labor allocation.

If we shift IC_f to $IC_f^{'}$ instead, then a similar graphical analysis applies, except that now the Nash equilibrium occurs at point P which is Pareto suboptimal. If we further shift IC_f to $IC_f^{''}$, which hits the PPF tangentially at a point to the right of point E, then the Nash equilibrium occurs at point E, where each spouse only works on their own plots. Such association among shifts in the IC, MRS and total household income only exists for the relatively labor-abundant spouse. As shown in Figure 4, holding IC_f constant and shifting IC_m to $IC_m^{'}$ has no influence on total household income.

So far, I have discussed the solution excluding the cases of $MRS > 1$. Adding them complicates the analysis to some extent. If $MRS_f * MRS_m < 1$ holds, then the relatively labor-abundant spouse's MRS still plays a determining role, and $MRS > 1$ also leads to inefficient input allocation. If instead $MRS_f * MRS_m > 1$, then either the relatively labor-abundant or the relatively labor-scarce spouse's MRS plays the determining role, and $MRS < 1$ and $MRS > 1$ would both lead to inefficiency loss in household income (See Appendix).

To sum it up, the model predicts that in most cases the spouse-regarding preference of the relatively labor-abundant spouse is associated with intrahousehold productive efficiency and therefore total household income. In general, the total household income reaches its upper bound when the MRS of the labor-abundant spouse equals one. If smaller than one, it is negatively correlated with total household income until it equals to or is smaller than MRT at point E and then the total household income stays at a lower bound. If larger than one, its deviation from one is also associated with inefficiency loss in income in a analogous way as when smaller than one.

5.4 Model extensions

Beyond the scope of the current model, if spouses can form a well-functioning intrahousehold labor market and make credible commitment about labor allocation and compensation, the intrahousehold productive inefficiency will vanish and total household income can always reach its maximum. Therefore one way to understand the current model is to view the noncooperative relationship as a commitment failure between spouses, i.e., the transaction/information cost is so high that the intrahousehold labor market does not exist or is imperfect.

Our stylized model can be interpreted more broadly. Each spouse's individual plots can be broadly interpreted as separate income-generating activities under his or her control, which can range from cultivation, raising livestocks, aquaculture, and any form of off-farm activities. In addition to land, factor K actually can represent any fixed inputs that determine individual earnings (e.g., financial capital), and in addition to labor, factor L can represent any variable inputs (e.g., knowledge or fertilizer). Individuals' labor endowments can also be interpreted in a broader sense to include any household labor or even hired labor (from an imperfect labor market) that is under an individual's control, and to exclude the amount of labor devoted to household duties as required by the gender-specific social norms.

Similar theoretical predictions will hold under various extensions of the model, for example, if spouses grow multiple and/or different crops, have different production technologies even for the same crop, face different market prices, or even conduct a variety of activities ranging from agriculture to small enterprises to supply of labor in an imperfect labor market.[11] The same model could also be used to describe intrahousehold input misallocations when spouses separate their individual earnings by the cultivation of gender-specific crops (Duflo and Udry, 2004).

[11] In an imperfect labor market where employment probability (or search costs) diminishes (increases) with the amount of labor supplied, the key assumption of diminishing returns to labor would still hold.

5.5 Interpreting the Empirical Results in Light of the Model

Assumptions

I argue that the empirical results found in this paper are consistent with the theoretical predictions of the proposed noncooperative household production model making the following assumptions:

1. The subjective values individuals put on payments given to their spouses relative to payments to themselves in the experiment, can be extrapolated beyond the experimental environment, and is equivalent to the theoretical concept of marginal rate of substitution (MRS) of spouses' earnings for one's own earnings. Note that the one-shot experimental payments are small amounts compared to the total household production profits in real life, thus it is reasonable to view them as marginal increases in individual earnings.

2. When facing the dichotomous choice of 1000 CFA for their spouses and 1000 CFA for themselves, those who have MRS's equal to one would appear to choose the 1000 CFA given to their spouses over the 1000 CFA given to themselves. Therefore, these individuals being "approximately indifferent" in the experiment have MRS's equal to one. Such an assumption is sensible as these individuals can get the warm-glow utility from such a choice at no cost of material utilities.

3. The spouse-regarding preferences are stable over time. Note that in our study, the preference experiment was conducted 1-2 years later than the collection of the household survey data.

4. No matter in monogamous or polygamous households, the two-person bargaining as in the model between the two most important household members determine intra-household productive efficiency. These two are assumed to be husband and wife in monogamous households, and husband and the first or second wife in polygamous

households.

According to the results above, it seems the relationship between the husband and the second wife seems to be more important in determining household production and income.

Interpretations

In light of the model, we derive following interpretations for the empirical findings:

1. The income gap between the different experimental types can be interpreted as the result of intrahousehold productive (in)efficiency. Intrahousehold productive efficiency will definitely be achieved if both spouses have MRS's equal to one; productive efficiency will possibly be achieved if only one spouse has MRS equal to one; productive inefficiency arises if neither spouse's MRS's equal to one. Therefore, the income gap between the (definitely or possibly) efficient households and the inefficient households can be interpreted as the efficiency loss for those 67% households in the household production process. Such an income gap is as large as 17 to 27 percent of their household income as in Table 5, which account for 11 to 18 percent of income loss for the whole sample. This is certainly an underestimate as when calculating the average loss, the 67% households who I assume have zero income loss may actually be suffering some income loss.

    (a) Such indirect evidence supporting intrahousehold productive inefficiency is consistent with the plot-level evidence like Udry (1996), who directly looked at data on intrahousehold allocation of productive inputs. Udry's work and other later studies all find a land productivity gap between plots under men's and women's control, which means that a net transfer of variable inputs like labor across plots under different spouses' control can result in more efficient input allocation and therefore greater household income. Together with the theoretical model, our

findings here indicate the causes why such input transfer within the family did not happen: separate spheres, limited commitment, and individual spouses' lack of willingness to act fully collectively ($MRS \neq 1$).

(b) Besides the individual plot cultivation system, our production model can also apply to other aspects of household production decisions wherever men and women face conflicts of interest. For example, in Sub-Saharan Africa, men and women traditionally cultivate different crops (Duflo and Udry, 2004), and crops under men's control are often more profitable. If women allocate more household inputs under her control to produce the crop that belongs to the man, she can increase the man's earnings at the cost of decreasing her own earnings. Depending on her spouse-regarding preference, she might not choose to invest enough in the more profitable crops, even though that means an increase in total household income. One empirical example of this is Jones (1986)'s study in Cameroon, where she finds that compared to independent women who control their rice yields themselves, married women under-allocate time to rice cultivation, whose income goes to their husbands.

(c) Beyond agriculture, the production process in small business-owner families can engage similar or even greater conflicts of individual interests, where individual spouses' lack of willingness to act collectively can lead to efficiency loss in household income enlarged by the new economic opportunities. Though the empirical approach can not distinguish in particular which production decision gives arise to the detected intrahousehold productive inefficiency, the estimated income loss here should have captured the efficiency loss from all different aspects of household production decisions, agricultural or not. Therefore, it is not surprising that my estimate of 11 to 18 percent income loss for the whole sample is already much greater than Udry's (1996) estimation of 6 percent.

2. Women's MRS's play an essential role in determining gaps in household income, indicating their relative abundance in certain productive inputs.

   (a) If labor allocation decision is most relevant, then the result implies that women are labor-abundant relative to men given their land endowments. This seems a little counter-intuitive considering the well-documented gender asymmetry in labor endowment in Sub-Sahara Africa. For example, Smock (1981) reviews evidence indicating that women often have lower energy levels, suffer from successive pregnancies and take on domestic chores and child-care responsibilities. Recent studies also verify that women face challenges in accessing, using, and supervising male farm labor, hired labor and other variable inputs like inorganic fertilizer and pesticides/herbicides, while her own labor is restricted by childcare responsibilities (Backiny-Yetna and McGee, 2015; Kilic et al., 2014). However, there are also evidence showing that women are more productive farm labors than men. Ram and Singh (1988) found that female agricultural labor in the Burkina Faso was six times more productive in farming than male labor. They conjectured that women's significantly younger age and competition between co-wives could partly explain the differences in productivity. In addition, women apparently have smaller plots with lower quality and less secure land tenure than men. Therefore, the deduction that women are relatively labor-abundant is not totally unrealistic.

   (b) Following the interpretation above, we can infer the direction of the land productivity gap. For those households where the woman has $MRS > 1$, land productivity of female-controlled plots should be lower than that of male-controlled plots within the household, because household labor is over-allocated on the man's plot. This is consistent with Udry's (1996) finding and other plot-level evidence. However, for the case where the woman has $MRS < 1$, the sign of the gender productivity difference will be opposite, thereby contradicts with Udry (1996) and others.

(c) If instead crop choice decision is most relevant, then the result implies that women are relatively input abundant given the prices of the gender-specific crops. Considering the higher profitability of men's crops, this can be a reasonable statement. In small business-owner households, if capital allocation across different lines of small business in the family is the most relevant decision, then the result implies that women are relatively capital abundant, which might seem unrealistic at first sight, but could be a result of recent development interventions targeting women as receivers of micro-finance.

(d) In terms of the two wives in polygamous households, the second wife seems to play a more essential role as the spouse-regarding preferences exhibit greater explanatory power for the M-2F sample compared to the M-1F sample. This can simply due to the younger age of the second wife, and the local context where the sequence or age of the wife does not necessarily decide the importance of her role in household resource allocations.

(e) However, such interpretations need to be taken with caution. The better performance of women's experimental measures compared to men's can also be due to the gender difference in their willingness to reveal one's true preference in lab-in-the-field experiments. One possible reason could be that women are often poorer than their husbands due to gender asymmetry in household resource allocation, so the monetary incentive can have a greater effect on women than men.

3. Both $MRS < 1$ and $MRS > 1$ lead to intrahousehold productive inefficiency, implying that self-interested and impure altruistic (or social norm complying) motivations can both prevent the realization of collective actions.

(a) The local context suggests that social norms probably explain why so many women in our sample have MRS's strictly larger than one, and it is associated with in-

come loss. Though women seem to enjoy a great extent of autonomy in terms of production asset ownership and decisions, the gender identity norm still emphasizes women's subordinate role at home. As pointed out by Abbas (1997), "subtle social mechanisms and ideologies play an important role in justifying unequal gender relations within the household [...]." As the model indicates, such social norms, absorbed in individual women's spouse-regarding preference, leads to suboptimal allocation of household productive inputs. Husband's plot gets too much labor input as the wife is *willingly* subordinate.

(b) Nevertheless, the real-world intrahousehold bargaining can be much more complicated than our stylized model. Alternatively, we might interpret MRS's greater than one as a sign that the bargaining is still an on-going process of trust building, in contrast to MRS's equal to one as a sign of Pareto optimality achieved by the bargaining process.

5.6 Alternative models

The empirical results can also be interpreted as providing a test of different household production models, as alternative models predict no correlation between total household income and spouse-regarding preferences. In Table 14 I summarize each model's assumptions of the production and consumption stages as well as their predictions concerning MRS's values and relationship between household income and MRS's. Below I introduce them one by one.

A unitary model like that of Becker (1974) assumes that a benevolent household head makes all consumption and production decisions, so the household acts like an individual. Therefore, earnings of different spouses are always equally valued by any household member, and total household income will always be maximized. A collective model as in Chiappori (1997) assumes that regardless of the bargaining process, spouses are able to reach Pareto efficient intrahousehold allocation. In particular, if we assume that the intrahousehold consumption allocation is collective, then MRS's will always be equal to one. If we do not specify

the consumption allocation, but assume that the intrahousehold productive allocation is collective, then MRS's can be either equal to or smaller than one, but the total household income will always be maximized regardless of the values of the MRS's. Therefore, empirically finding a correlation between individual spouses' MRS's and household income rejects both unitary and collective model, supporting the existence of intrahousehold productive inefficiency.

Other noncooperative production models propose alternative causes of intrahousehold productive inefficiency. Both Lundberg and Pollak (1994) and Basu (2006) assume that the intrahousehold consumption allocation is efficient given each spouse's current bargaining power. However, productive inefficiency arises as current individual earnings have an impact on each spouse's future bargaining power, and spouses' strategic thinking causes them to make Pareto inefficient production decisions when facing trade-offs between current individual earnings. However, it still predicts that an individual should always marginally value his own earnings and his spouse's earnings equivalently. This is because spouses' bargaining power should be a relatively stable concept, and marginal increases in individuals' earnings, like payments in the experiment, should not be able to alter it.

Telalagic (2014) proposes a different reason for intrahousehold productive inefficiency. She assumes if the couple stays married, intrahousehold consumption allocation is collective. However, there is always a positive probability of divorce in the next period, and if the couple divorces, each person will only benefit from his own individual earnings and not from the spouse's individual earnings any more. Therefore the current input allocation can be suboptimal as spouses over-invest in activities that yield future individual earnings, even though both spouses should have MRS's equal to one in the current period. In terms of the experiment, the probability of divorce before expending all the experimental payments is very close to, if not equal to, zero.

In sum, only the noncooperative household production model that predicts intrahousehold productive inefficiency within the current period can reconcile the empirical correlation

we find.

6 Conclusion and Discussions

The findings in this paper highlight the relevance of social preferences between spouses within households, and verify the noncooperative nature of household production and the existence of intrahousehold productive inefficiency. As poor populations, the producer-consumer households we study, are vulnerable to any efficiency loss on top of their already meager earning potentials. Given their large numbers, even small efficiency loss for each household can add up at the macro level. However, direct intervening to alter spouse-regarding preferences and rid intrahousehold productive inefficiency, does not seem feasible nor proper. Total household income is far from a valid indicator for household members' welfare. Pointing out the potential cost of productive efficiency loss, simply better prepares policy-makers for well-informed decisions when facing trade-offs.

First, development interventions might have un-intended consequences and exacerbate intrahousehold productive inefficiency. Various projects ranging from micro-fiancee to education campaigns serve the policy goal of empowering women, which has both great intrinsic and instrumental values. Caution needs to be taken, as altering individual spouses' relative endowments in production inputs and their bargaining powers in terms of acquiring consumption resources, can lead to unexpected shifts in the intrahousehold input allocation dynamics. It might pay off to have husbands involve more in the women empowering project in carefully-designed manners.

Second, understanding intrahousehold bargaining dynamics provide insights on what measures can effectively improve gender equality. There has been mounting evidence showing that in Sub-Saharan Africa the land productivity on plots under women's control is much lower than that under men's control either across or within households (see a review in Kilic et al., 2014). This paper suggests that the barrier could be as subtle as social norms

that emphasize women's subordinate roles, which can prohibit the empowering effect of, for example, direct resource transfers.

Last but not least, interventions based on the assumption of unitary or collective household model can limit the benefits new economic technologies and opportunities bring to the poor (Abbas, 1997). For example, Dey (1981) and Von Braun and Webb (1989) reported three development projects in Gambia that introduced irrigated rice to male farmers despite that women were traditionally rice growers in this area. The policy makers assume that women would automatically take part in the men's rice cultivation and contribute their experience and expertise. However, such a failure to appreciate the separate spheres within the household production was proven a deficiency in the project design and led to low rice production levels. In a different setting, McPeak and Doss (2006) find that the benefit of increasing milk marketing for the nomadic pastoralist households in northern Kenya is limited by the individual spouses' interest conflict as well. In the current paper, I also find evidence suggesting that the intrahousehold productive efficiency loss probably is greater among small business-owner households than among farmer households. This cautions policy makers to really consider intrahousehold aspects transitioning traditional economies.

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Figures and Tables

Figure 1: Histogram of women's switch point in the experiment

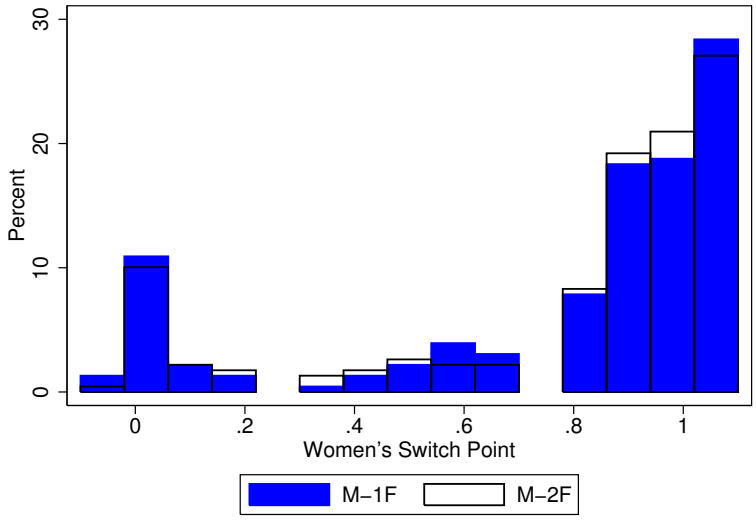


Figure 2: Histogram of men's switch point in the experiment

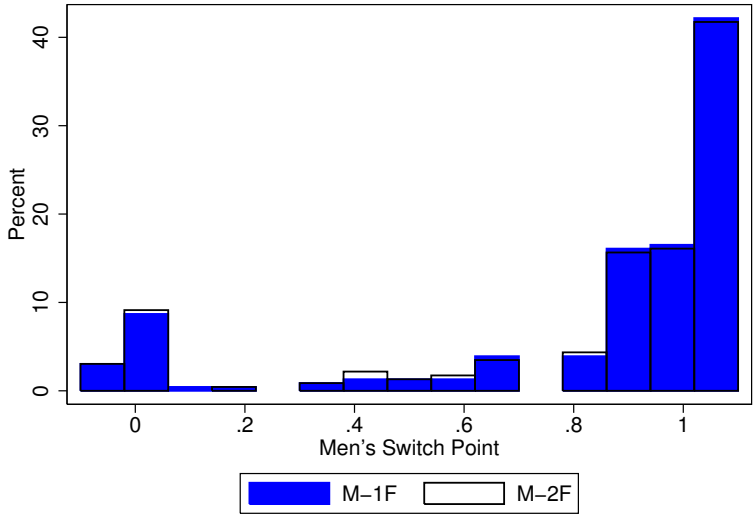


Figure 3: Enumerators' ratings of the respondents' understanding levels (monogamous sample)

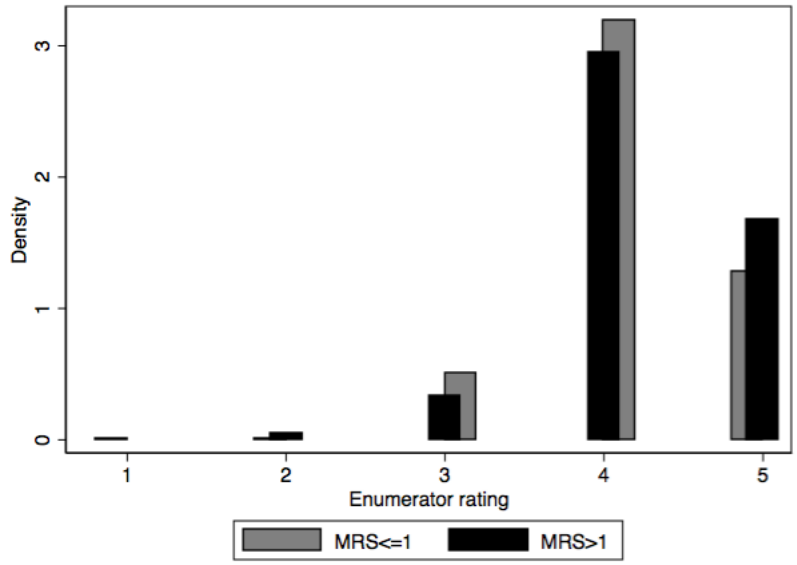
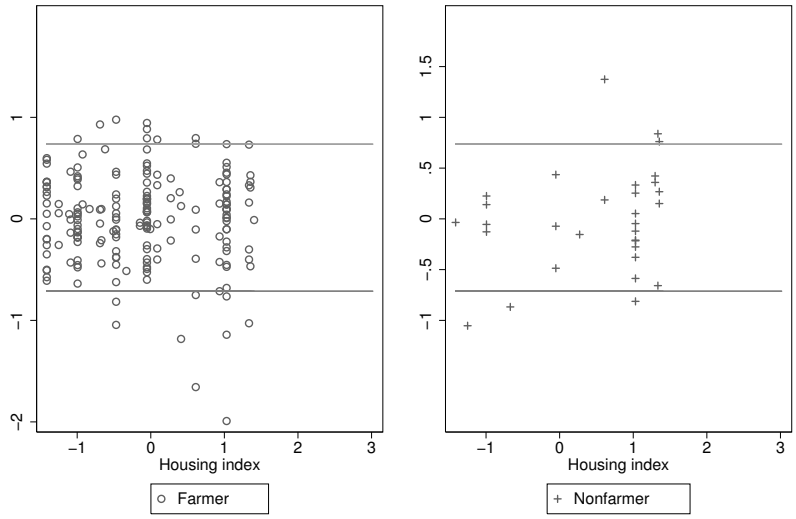


Figure 4: The residuals from the basic model against the housing quality index, separating farm and non-farm households



*Note: the scatter graph for the farmer households is jittered.
**Note: The tow lines are respectively the upper and lower bound of the 95% IC for each group.

Figure 5: The Indifference Curves and the Slopes as MRS's

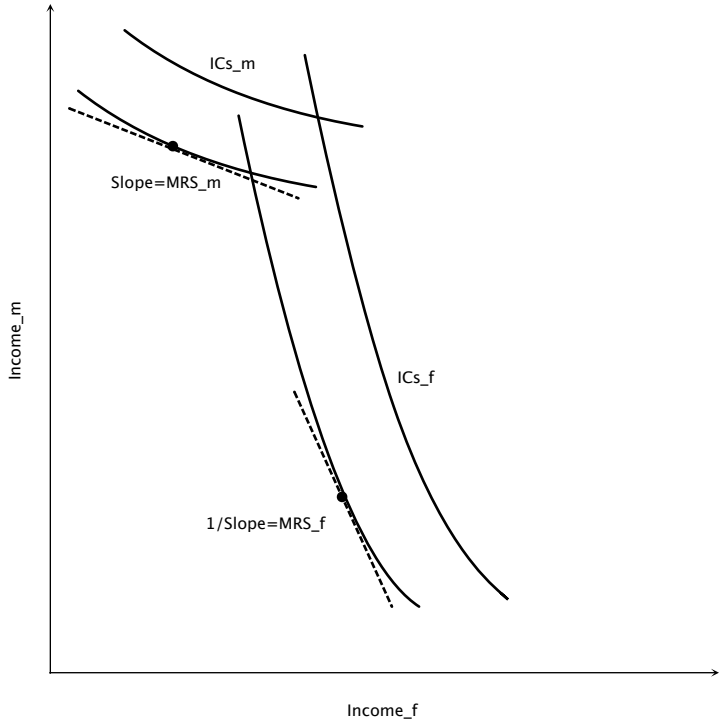


Figure 6: The Production Possibility Frontier in Terms of I_f and I_m

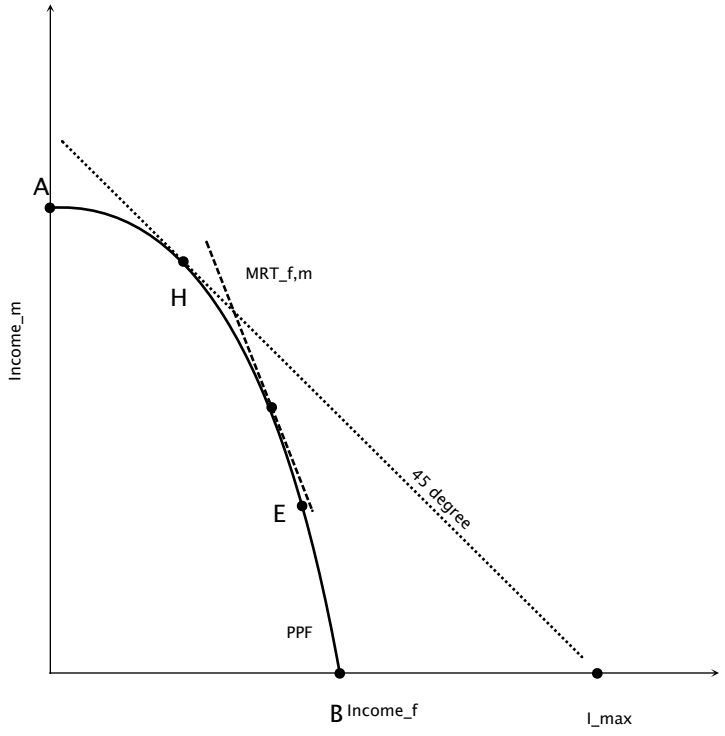


Figure 7: The Man and Woman's Most Preferred Income Outcomes

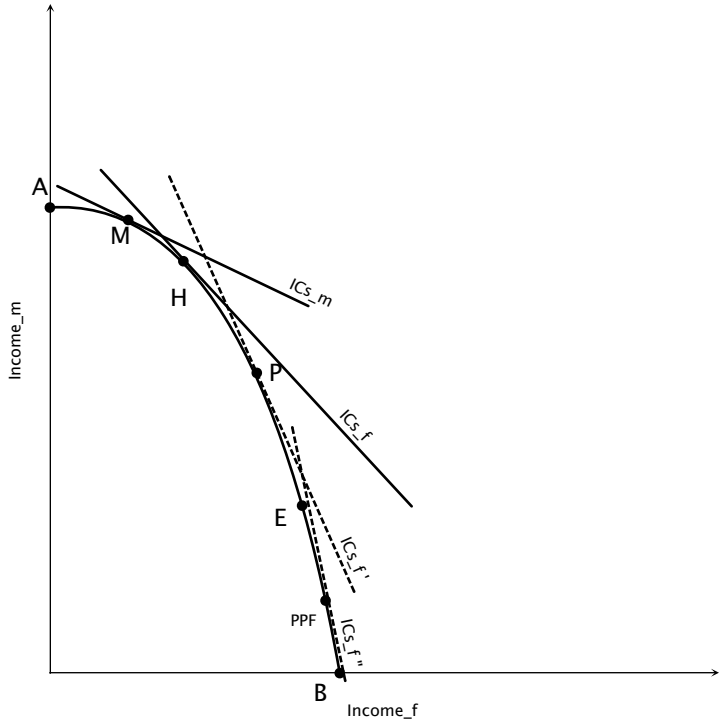


Figure 8: The Woman Has No Incentive to Move from the Autarky Point

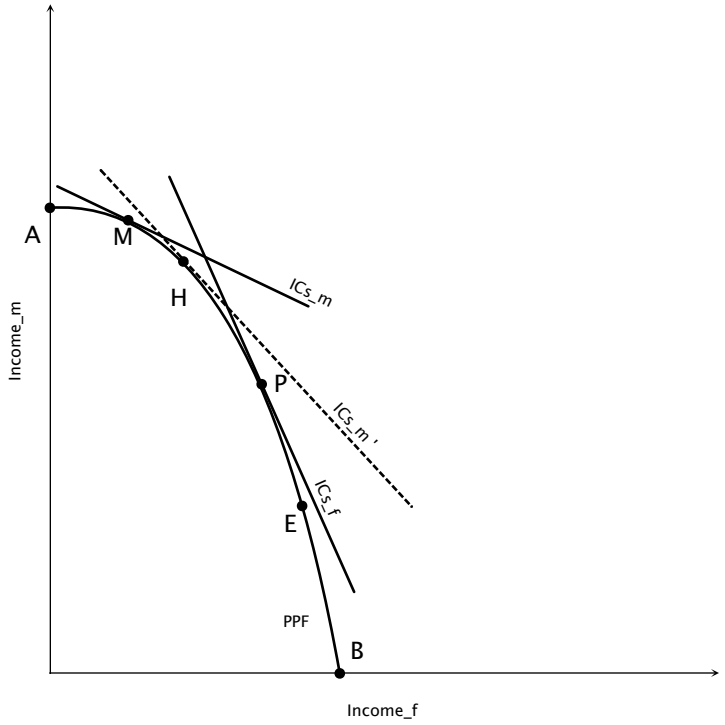


Table 1: Summary statistics of variables from the survey data

	mean	sd	min	max	count
Income and Occupation					
Household daily expenditure (in dollars)	5.57	4.46	0.56	31.43	228
Per capita daily expenditure (in dollars)	0.98	0.83	0.15	6.45	229
Whether polygamy	0.34	0.48	0.00	1.00	230
Whether the man is farmer	0.85	0.36	0.00	1.00	230
Physical assets					
Total land area (in hectars)	6.44	6.00	0.00	40.50	230
Livestock index	3.56	4.07	0.00	31.96	230
Household labor	3.82	1.90	2.00	14.00	227
Human capital					
The man's years of schooling	1.54	2.79	0.00	13.00	229
The woman's years of schooling	0.71	1.88	0.00	10.00	229
Social capital					
Whether the man joins production-related associations	0.68	0.47	0.00	1.00	230
Whether the woman joins production-related associations	0.36	0.48	0.00	1.00	230
Whether the man joins credit associations	0.04	0.20	0.00	1.00	230
Whether the woman joins credit associations	0.40	0.49	0.00	1.00	230
Financial capital					
Housing index	-0.01	0.92	-1.41	3.02	230
Asset index	0.03	0.99	-1.68	2.40	230
Observations	230				

*Note: Expenditures are converted from West African CFA franc to 4th quarter 2011 USD.

Table 2: Dichotomous Choice Questions in a Multiple Price List

Questions	1	2	3	...	...	10	11	12	13	14
Option A:	(1100, 0)	(1000, 0)	(900, 0)	...	...	(200, 0)	(100, 0)	(50, 0)	(25, 0)	(0, 0)
Option B:	(0, 1000)	(0, 1000)	(0, 1000)	...	...	(0, 1000)	(0, 1000)	(0, 1000)	(0, 1000)	(0, 1000)

Table 3: Pairwise distribution of spouses' experimental choices (M-1F sample)

	Husband			
	Prefers own payoffs	Indifferent	Strictly prefers spouse's payoffs	Total
Wife: prefers own payoffs	55	19	47	121
	(23.91)	(8.261)	(20.43)	(52.61)
Wife: indifferent	15	7	21	43
	(6.522)	(3.043)	(9.130)	(18.70)
Wife: strictly prefers spouse's payoffs	25	12	29	66
	(10.87)	(5.217)	(12.61)	(28.70)
Total	95	38	97	230
	(41.30)	(16.52)	(42.17)	(100)
Observations	230			

b coefficients; pct in parentheses

Percentage points in the parentheses

Table 4: Pairwise distribution of spouses' experimental choices (M-2F sample)

	Husband			
	Prefers own payoffs	Indifferent	Strictly prefers spouse's payoffs	Total
Wife: prefers own payoffs	60	17	42	119
	(26.09)	(7.391)	(18.26)	(51.74)
Wife: indifferent	16	7	25	48
	(6.957)	(3.043)	(10.87)	(20.87)
Wife: strictly prefers spouse's payoffs	21	13	29	63
	(9.130)	(5.652)	(12.61)	(27.39)
Total	97	37	96	230
	(42.17)	(16.09)	(41.74)	(100)
Observations	230			

b coefficients; pct in parentheses

Percentage points in the parentheses

Table 5: OLS Results with Household-level Experimental Types

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	lg(Income)	lg(Income)	lg(Income)	lg(Income)	lg(Income)	lg(Income)	lg(Income)	lg(Income)	lg(Income)
Whether the man is farmer	-0.641***	-0.601***	-0.607***	-0.604***	-0.594***	-0.532***	-0.600***	-0.593***	-0.515***
	(0.149)	(0.204)	(0.138)	(0.115)	(0.115)	(0.150)	(0.141)	(0.112)	(0.152)
Total land area * If the man is farmer	0.0424**	0.0505***	0.0387**	0.0383**	0.0362**	0.0431***	0.0386**	0.0391**	0.0437***
	(0.0155)	(0.0143)	(0.0151)	(0.0142)	(0.0142)	(0.0141)	(0.0154)	(0.0146)	(0.0145)
Total land area (in hectars)	-0.0261*	-0.0274***	-0.0239*	-0.0227*	-0.0223*	-0.0245***	-0.0234*	-0.0226*	-0.0241***
	(0.0129)	(0.00701)	(0.0131)	(0.0126)	(0.0126)	(0.00681)	(0.0132)	(0.0126)	(0.00680)
Livestock index	0.0138	0.0140	0.0145	0.0140	0.0148	0.0164	0.0142	0.0135	0.0154
	(0.0178)	(0.0200)	(0.0175)	(0.0165)	(0.0170)	(0.0188)	(0.0176)	(0.0162)	(0.0184)
Household labor	0.0681**	0.0694**	0.0650**	0.0640**	0.0650**	0.0651**	0.0666**	0.0644**	0.0659**
	(0.0270)	(0.0304)	(0.0281)	(0.0284)	(0.0273)	(0.0279)	(0.0274)	(0.0280)	(0.0255)
The man's years of schooling	0.0124	-0.000914	0.0129	0.0142	0.0124	0.00146	0.0138	0.0164	0.00356
	(0.0142)	(0.0148)	(0.0149)	(0.0142)	(0.0146)	(0.0138)	(0.0140)	(0.0125)	(0.0128)
The woman's years of schooling	-0.000370	-0.0192	0.000442	-0.00346	-0.00318	-0.0257	0.000878	-0.00422	-0.0277
	(0.0175)	(0.0446)	(0.0153)	(0.0132)	(0.0146)	(0.0408)	(0.0156)	(0.0129)	(0.0399)
Whether the man joins production-related associations	0.00645	0.0607	-0.0134	-0.00213	-0.00589	0.0632	-0.0235	-0.00798	0.0445
	(0.0707)	(0.0840)	(0.0684)	(0.0618)	(0.0612)	(0.0709)	(0.0719)	(0.0659)	(0.0688)
Whether the woman joins production-related associations	-0.0116	-0.133	0.0119	0.0164	0.0172	-0.101	0.0107	0.0157	-0.0891
	(0.0798)	(0.109)	(0.0774)	(0.0760)	(0.0779)	(0.110)	(0.0762)	(0.0775)	(0.118)
Whether the man joins credit associations	0.0736	-0.00586	0.0871	0.0694	0.0755	-0.0114	0.104	0.0863	0.0144
	(0.0983)	(0.110)	(0.112)	(0.114)	(0.120)	(0.159)	(0.0968)	(0.0887)	(0.143)
Whether the woman joins credit associations	0.0881	0.139*	0.0912	0.0915	0.0914	0.155**	0.0887	0.0853	0.140*
	(0.0607)	(0.0711)	(0.0566)	(0.0533)	(0.0543)	(0.0703)	(0.0582)	(0.0534)	(0.0687)
Housing index	0.184**	0.274***	0.188***	0.203***	0.196***	0.295***	0.186**	0.203***	0.294***
	(0.0710)	(0.0673)	(0.0663)	(0.0633)	(0.0607)	(0.0585)	(0.0691)	(0.0661)	(0.0585)
Asset index	0.0481	0.0391	0.0348	0.0270	0.0309	0.0185	0.0341	0.0257	0.0176
	(0.0913)	(0.0819)	(0.0928)	(0.0872)	(0.0859)	(0.0803)	(0.0957)	(0.0887)	(0.0845)
Whether polygamy	0.292*		0.328*	0.336**	0.378**		0.321*	0.323**	
	(0.155)		(0.160)	(0.152)	(0.144)		(0.161)	(0.152)	
Experimental types:									
Either man or woman indifferent between payments			0.169**	0.241***	0.261***	0.269***			
			(0.0785)	(0.0742)	(0.0587)	(0.0617)			
Both man and woman indifferent							0.0627	0.0640	0.134
							(0.128)	(0.148)	(0.173)
Only the man indifferent							0.108	0.167**	0.176**
							(0.0743)	(0.0678)	(0.0651)
Only the woman indifferent							0.234*	0.315**	0.372***
							(0.113)	(0.117)	(0.102)
Observations	223	146	223	223	223	146	223	223	146
Adjusted R^2	0.429	0.447	0.439	0.454	0.452	0.484	0.436	0.454	0.486
F_test			0.0430	0.00390	0.000229	0.000282	0.203	0.0218	0.00161
Sample	FULL	MONOGAMY	M-1F	M-2F	All households	Monogamy	M-1F	M-2F	Monogamy

Standard errors in parentheses

Standard errors are clustered at the village level. Covariates also include 22 village dummies in all columns.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: OLS Results with Detailed Household-level Experimental Types

	(1) lg(Income)	(2) lg(Income)	(3) lg(Income)	(4) lg(Income)	(5) lg(Income)	(6) lg(Income)
Both prefer own payoffs	-0.172*	-0.305***	-0.174*	-0.313***	-0.306***	-0.315***
	(0.0927)	(0.0823)	(0.0933)	(0.0891)	(0.0828)	(0.0881)
Both strictly prefer spouses' payoffs	-0.129	-0.235**	-0.130	-0.271**	-0.235**	-0.271**
	(0.0928)	(0.108)	(0.0942)	(0.127)	(0.108)	(0.128)
One prefers own, the other prefers spouse's payoffs	-0.187*	-0.183*		-0.222**		
	(0.0991)	(0.102)		(0.0907)		
Man prefers own, woman prefers spouse's payoffs			-0.259**		-0.130	-0.315*
			(0.114)		(0.103)	(0.155)
Woman prefers own, man prefers spouse's payoffs			-0.148		-0.211	-0.184
			(0.108)		(0.130)	(0.108)
Observations	223	223	223	146	223	146
Adjusted R^2	0.434	0.453	0.433	0.477	0.451	0.475
F_test	0.238	0.00899	0.246	0.00268	0.0175	0.00592
Sample	M-1F	M-2F	M-1F	MONOGAMY	M-2F	MONOGAMY

Standard errors in parentheses

Standard errors are clustered at the village level. Covariates include all the variables in column (1) of Table 8.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: OLS Results with Individual Experimental Types

	(1) lg(Income)	(2) lg(Income)	(3) lg(Income)	(4) lg(Income)	(5) lg(Income)	(6) lg(Income)	(7) lg(Income)	(8) lg(Income)	(9) lg(Income)	(10) lg(Income)	(11) lg(Income)	(12) lg(Income)
Woman indifferent	0.187*	0.248**	0.288***									
	(0.0917)	(0.101)	(0.0862)									
Woman prefers own payoffs				-0.191	-0.287**	-0.290**						
				(0.115)	(0.119)	(0.118)						
Woman strictly prefers spouse's payoffs				-0.182**	-0.195*	-0.285**						
				(0.0781)	(0.108)	(0.107)						
Man indifferent							0.0443	0.0758	0.0655			
							(0.0574)	(0.0678)	(0.0805)			
Man prefers own payoffs										-0.0585	-0.103	-0.102
										(0.0749)	(0.0838)	(0.106)
Man strictly prefers spouse's payoffs										-0.0299	-0.0467	-0.0286
										(0.0574)	(0.0694)	(0.0860)
Observations	223	223	146	223	223	146	223	223	146	223	223	146
Adjusted R^2	0.438	0.450	0.481	0.435	0.450	0.476	0.427	0.428	0.444	0.424	0.426	0.441
F_test	0.0541	0.0230	0.00312	0.0888	0.0690	0.00968	0.449	0.276	0.425	0.736	0.477	0.628
Sample	M-1F	M-2F	Monogamy	M-1F	M-2F	Monogamy	M-1F	M-2F	Monogamy	M-1F	M-2F	Monogamy

Standard errors in parentheses

Standard errors are clustered at the village level. Covariates include all the variables in column (1) of Table 4.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: OLS Results with Men and Women's Individual Experimental Types Both Included

	(1) lg(Income)	(2) lg(Income)	(3) lg(Income)	(4) lg(Income)	(5) lg(Income)	(6) lg(Income)
Woman indifferent	0.191*	0.252**	0.295***			
	(0.0923)	(0.103)	(0.0919)			
Man indifferent	0.0592	0.0932	0.0930			
	(0.0589)	(0.0683)	(0.0780)			
Woman prefers own payoffs				-0.191	-0.284**	-0.288**
				(0.114)	(0.122)	(0.123)
Woman strictly prefers spouse's payoffs				-0.187**	-0.201*	-0.303**
				(0.0808)	(0.112)	(0.120)
Man prefers own payoffs				-0.0666	-0.101	-0.129
				(0.0746)	(0.0819)	(0.106)
Man strictly prefers spouse's payoffs				-0.0506	-0.0667	-0.0609
				(0.0614)	(0.0731)	(0.0936)
Observations	223	223	146	223	223	146
Adjusted R^2	0.436	0.449	0.479	0.430	0.447	0.472
F_test	0.127	0.0346	0.0108	0.272	0.0750	0.0450
Sample	M-1F	M-2F	Monogamy	M-1F	M-2F	Monogamy

Standard errors in parentheses

Standard errors are clustered at the village level. Covariates include all the variables in column (1) of Table 4.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Hetereogeneous effects of the experimental measures

	(1) lg(Income)	(2) lg(Income)	(3) lg(Income)	(4) lg(Income)	(5) lg(Income)	(6) lg(Income)	(7) lg(Income)
If the man is not a farmer	0.426***	0.356***	0.429***	0.583***	0.555***	0.555***	0.429***
	(0.0944)	(0.0900)	(0.0920)	(0.112)	(0.0997)	(0.0946)	(0.0935)
Housing index	0.181**	0.172**	0.157**	0.195***	0.192***	0.151**	0.181**
	(0.0654)	(0.0619)	(0.0710)	(0.0586)	(0.0600)	(0.0704)	(0.0640)
Asset index	0.0340	0.0192	0.0400	0.0310	0.00193	0.0419	0.0338
	(0.0846)	(0.0818)	(0.0864)	(0.0847)	(0.0814)	(0.0885)	(0.0839)
Whether polygamy	0.376**	0.380**	0.377**	0.404**	0.383**	0.379**	0.396**
	(0.140)	(0.138)	(0.138)	(0.154)	(0.138)	(0.139)	(0.151)
Either man or woman indifferent between payments	0.201***	0.223***	0.217***	0.294***	0.271***	0.271***	0.230***
	(0.0689)	(0.0771)	(0.0722)	(0.0613)	(0.0611)	(0.0629)	(0.0753)
Either man or woman indifferent between payments * If the man is not a farmer	0.428***	0.396***	0.360***				0.400***
	(0.100)	(0.131)	(0.113)				(0.0997)
Either man or woman indifferent between payments * Asset index		0.0863			0.130*		
		(0.0710)			(0.0649)		
Either man or woman indifferent between payments * Housing index			0.0705			0.118	
			(0.0678)			(0.0689)	
Either man or woman indifferent between payments * Polygamy				-0.279			-0.209
				(0.232)			(0.239)
Observations	223	223	223	223	223	223	223
Adjusted R^2	0.459	0.458	0.458	0.452	0.456	0.454	0.458
F_test	0.00000168	3.50e-11	0.000000246	0.000349	0.000773	0.000494	0.00000573

Standard errors in parentheses

All standard errors are clustered at the village level. Covariates include all the variables in column (1) of Table 8.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Heterogeneous Effect in Terms of Who is Labor Abundant

	(1) lg(Income)	(2) lg(Income)	(3) lg(Income)	(4) lg(Income)	(5) lg(Income)	(6) lg(Income)
Woman prefers own payoffs	-0.113	-0.256*	-0.221			
	(0.130)	(0.128)	(0.132)			
Woman strictly prefers spouse's payoffs	-0.118	-0.164	-0.234**			
	(0.100)	(0.110)	(0.112)			
Woman prefers own payoffs* If the man is not farmer	-0.512*	-0.222	-0.413			
	(0.278)	(0.324)	(0.254)			
Woman strictly prefers spouse's payoffs * If the man is not farmer	-0.378	-0.211	-0.268			
	(0.306)	(0.188)	(0.249)			
Man prefers own payoffs				-0.0449	-0.0561	-0.0500
				(0.0919)	(0.0926)	(0.132)
Man strictly prefers spouse's payoffs				-0.0432	-0.0320	0.0446
				(0.0783)	(0.0794)	(0.106)
Man prefers own payoffs* If the man is not farmer				-0.0740	-0.308	-0.325
				(0.312)	(0.253)	(0.271)
Man prefers own payoffs* If the man is not farmer				0.0968	-0.124	-0.420
				(0.313)	(0.267)	(0.246)
Observations	223	223	146	223	223	146
Adjusted R^2	0.440	0.446	0.476	0.419	0.423	0.438
Basic_model						
F_test	0.0332	0.0918	0.0103	0.414	0.301	0.205
Sample	M-1F	M-2F	Monogamy	M-1F	M-2F	Monogamy

Standard errors in parentheses

Standard errors are clustered at the village level. Covariates include all the variables in column (1) of Table 8.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Predictions of Different Household Production Models

Model Type	Production	Consumption	MRS's Values	I_h - MRS Relationship
Becker (1974)	Unitary	Unitary	MRS=1	No correlation
Chiappori (1997)	Collective	Unspecified	Unspecified	No correlation
Lundberg and Pollak (1994) and Basu (2006)	Noncooperative	Collective	MRS=1	No correlation
Telalagic (2014)	Noncooperative	Collective	MRS=1	No correlation
Model in the Current Paper	Noncooperative	Unspecified	Unspecified	Inverse-U shape

A Appendix is available upon request.

Table 11: Regressing the experimental measures on asset variables

	(1) HH Type	(2) HH Type	(3) HH Type	(4) Woman's Type	(5) Woman's Type	(6) Man's Type	(7) Man's Type
Whether the man is farmer	-0.0724	-0.0807	-0.0677	-0.0183	-0.0537	0.0145	0.0417
	(0.180)	(0.190)	(0.177)	(0.120)	(0.136)	(0.0936)	(0.0795)
Total land area * If the man is farmer	0.0144	0.0198*	0.0181*	0.00745	0.0104	0.00441	0.00696
	(0.00873)	(0.0109)	(0.00987)	(0.00723)	(0.00737)	(0.00563)	(0.00591)
Total land area (in hectars)	-0.0124*	-0.0170	-0.0139*	-0.0119**	-0.0142**	-0.00264	-0.00496
	(0.00609)	(0.0106)	(0.00809)	(0.00455)	(0.00654)	(0.00512)	(0.00580)
Livestock index	-0.00164	0.00315	-0.00266	0.00366	0.00922	-0.00269	-0.00347
	(0.00776)	(0.0104)	(0.00704)	(0.00760)	(0.00943)	(0.00602)	(0.00560)
Household labor	0.0194	0.0109	0.0100	-0.00597	-0.00595	0.0262	0.0177
	(0.0177)	(0.0179)	(0.0153)	(0.0155)	(0.0204)	(0.0171)	(0.0155)
The man's years of schooling	-0.00383	-0.00542	0.000865	-0.00281	-0.00723	0.00474	0.00757
	(0.00886)	(0.0103)	(0.00855)	(0.00739)	(0.0115)	(0.0123)	(0.0111)
The woman's years of schooling	-0.00608	0.00694	0.00555	-0.00838	0.00348	-0.00416	-0.00301
	(0.0221)	(0.0229)	(0.0193)	(0.0116)	(0.0149)	(0.0177)	(0.0172)
Whether the man joins production-related associations	0.134	0.0698	0.0980	0.130*	0.0743	0.0204	0.0113
	(0.0867)	(0.0769)	(0.0825)	(0.0745)	(0.0725)	(0.0714)	(0.0734)
Whether the woman joins production-related associations	-0.165**	-0.111**	-0.120**	-0.0613	-0.0243	-0.0984**	-0.0809*
	(0.0694)	(0.0514)	(0.0451)	(0.0673)	(0.0424)	(0.0421)	(0.0451)
Whether the man joins credit associations	-0.0739	-0.0214	-0.0391	-0.0526	-0.00375	0.0727	0.0763
	(0.149)	(0.150)	(0.138)	(0.104)	(0.145)	(0.143)	(0.142)
Whether the woman joins credit associations	-0.0515	-0.0530	-0.0472	-0.0472	-0.0381	-0.0471	-0.0576
	(0.0629)	(0.0605)	(0.0599)	(0.0426)	(0.0456)	(0.0690)	(0.0687)
Housing index	-0.0199	-0.0321	-0.0278	0.0105	0.00422	-0.0153	-0.0213
	(0.0801)	(0.0742)	(0.0819)	(0.0548)	(0.0479)	(0.0813)	(0.0811)
Asset index	0.0910	0.0453	0.0555	0.0594	0.0131	0.0220	0.0225
	(0.0614)	(0.0616)	(0.0598)	(0.0472)	(0.0414)	(0.0479)	(0.0478)
Whether polygamy	-0.238***	-0.163	-0.349***	-0.118**	-0.0452	-0.169**	-0.167**
	(0.0693)	(0.0991)	(0.0722)	(0.0538)	(0.0706)	(0.0660)	(0.0653)
Observations	225	225	225	225	225	225	225
Adjusted R^2	0.044	-0.011	0.102	0.010	-0.043	0.001	0.007

Standard errors in parentheses

Standard errors are clustered at the village level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Adding more covarites to the OLS regression

	(1) lg(Income)	(2) lg(Income)	(3) lg(Income)	(4) lg(Income)	(5) lg(Income)	(6) lg(Income)	(7) lg(Income)	(8) lg(Income)	(9) lg(Income)	(10) lg(Income)
Either man or woman indifferent between payments	0.162**	0.257***	0.252***	0.215***	0.219**					
	(0.0750)	(0.0604)	(0.0664)	(0.0704)	(0.0792)					
Both prefer own payoffs						-0.291**	-0.303***	-0.306***	-0.294***	-0.315***
						(0.105)	(0.0834)	(0.0878)	(0.0904)	(0.0961)
Both strictly prefer spouses' payoffs						-0.234**	-0.210*	-0.229*	-0.127	-0.137
						(0.110)	(0.113)	(0.115)	(0.106)	(0.109)
One prefers own, the other prefers spouse's payoffs						-0.0995	-0.192*	-0.182*	-0.146	-0.171
						(0.0803)	(0.104)	(0.102)	(0.109)	(0.117)
Observations	223	223	223	215	212	223	223	223	215	212
Adjusted R^2	0.334	0.454	0.458	0.450	0.459	0.347	0.454	0.461	0.454	0.466
Sample	All households	All households	All households	All households	All households	M-2F	M-2F	M-2F	M-2F	M-2F
Basic_model	0.326	0.431	0.438	0.435	0.444	0.326	0.431	0.438	0.435	0.444
F_test	0.0420	0.000347	0.00107	0.00609	0.0115	0.0258	0.0111	0.0133	0.0313	0.0285
Exclude_wealth_indecies	YES	NO	NO	NO	NO	YES	NO	NO	NO	NO
Add_more_SES	NO	YES	YES	YES	YES	NO	YES	YES	YES	YES
Add_husband_habit	NO	NO	YES	YES	YES	NO	NO	YES	YES	YES
Add_personal_plot_area	NO	NO	NO	YES	YES	NO	NO	NO	YES	YES
Add_experiment_understanding	NO	NO	NO	NO	YES	NO	NO	NO	NO	YES

Standard errors in parentheses

Standard errors are clustered at the village level. Fewer or more covariates are included in addition to those in column (1) of Table 8.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: OLS results with the additional experimental type of switching at 900 CFA

	(1)	(2)	(3)
Woman switches at 900 CFA	-0.0856	-0.208	0.0733
	(0.118)	(0.288)	(0.124)
Woman switches at 800 CFA or less	-0.165	-0.297**	-0.317**
	(0.121)	(0.114)	(0.122)
Woman strictly prefers spouse's payoffs	-0.184**	-0.194*	-0.281**
	(0.0779)	(0.109)	(0.109)
Observations	223	223	146
Adjusted R^2	0.434	0.448	0.473
Sample	M-1F	M-2F	Monogamy
F_test	0.150	0.0995	0.00714

Standard errors in parentheses

All standard errors are clustered at the village level. Fewer or more covariates are included in addition to those in column (1) of Table 8.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$